Tracking Chlorofluorocarbons in a Global Eddying Ocean Model

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The ocean plays a critical role in the earth's balance of heat, water, and chemicals such as carbon dioxide. After exchanging properties with the atmosphere at the surface, the ocean can store energy and dissolved gases for hundreds to thousands of years at depth. This "ventilation" process, which ultimately influences climate, is very difficult to measure directly, but can be inferred from observations of dissolved chemical compounds if enough is known about the ocean circulation.

One particularly useful class of chemical tracers for seeing how chemicals are moved through the ocean is chlorofluorocarbons (CFC), which human activity has introduced into the atmosphere. CFCs are ideal for inferring ventilation pathways and times cales in the ocean, because they have a well-known atmospheric time history and solubility, and they are inert once in the ocean (unlike, for example, oxygen and carbon dioxide). The task then becomes to relate the measured CFC concentration to its equilibrium surface value in order to determine the ventilation age of the water. However, to obtain a meaningful result, researchers also need accurate information about how the water was transported to the observed location. This is where Ocean General Circulation Models (OGCM) can play an important role by providing insight into transport processes.

Most previous studies of CFC distributions using ocean models have been done using fairly coarse resolutions (grid spacing greater than 100 km), for which some important transport processes are either poorly resolved or parameterized. We have vastly improved upon previous work by performing a simulation of the ocean circulation in the eddying regime (grid spacing of 10 km or less) that explicitly resolves the mesoscale oceanic transport. In order to obtain information about ventilation processes and pathways, a host of model tracers, including CFCs, were carried along in the century-long run.

The distribution of CFCs in the model (Fig. 1) compares very well with what has been measured from research vessels in the ocean, which provides critical model validation. A number of interesting questions will be addressed with the output from this simulation, including quantifying the level of eddy "noise" that is likely to be present in the measurements, and understanding the biases that are present when using CFCs to estimate the ventilation age of the sampled water. Studies such as these, which use a combination of modeling and real-world measurements to gain insight into oceanic transport processes, will be crucial as we improve our understanding of the ocean's role in the earth's climate system.

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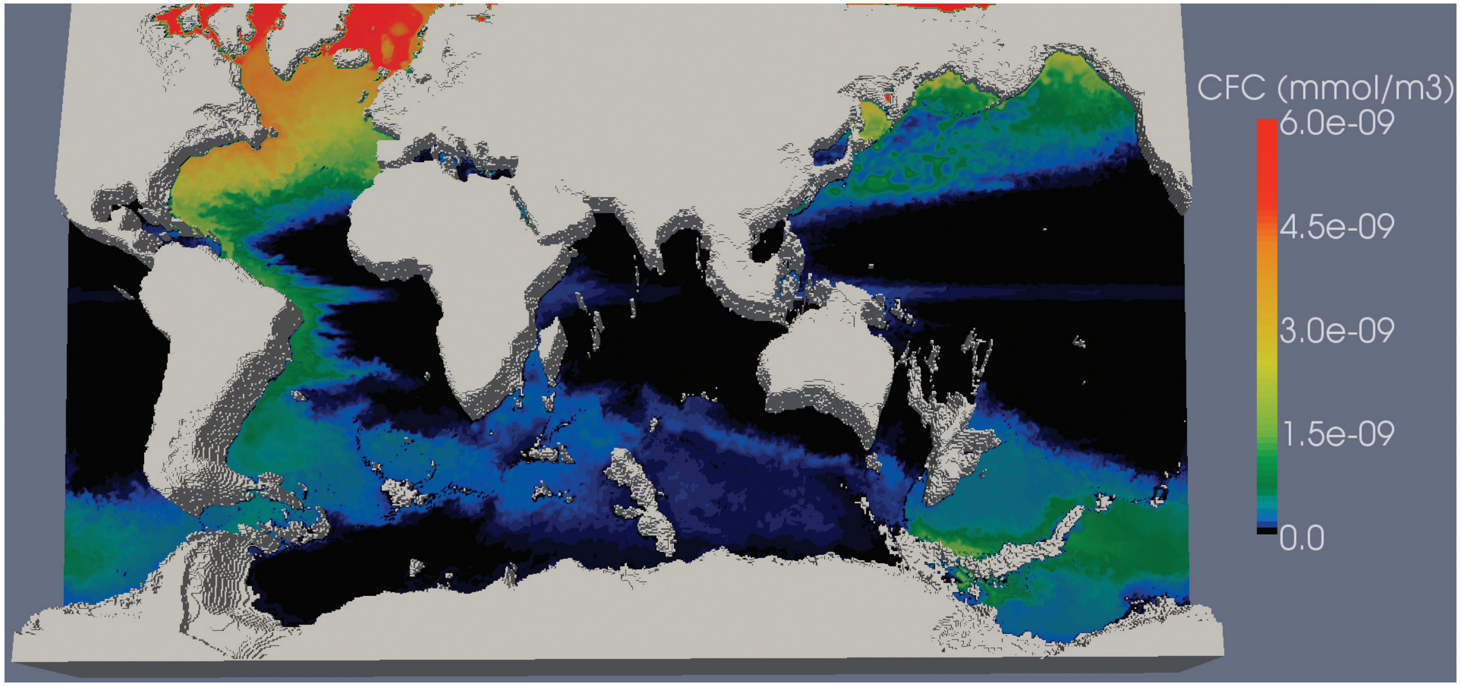

Fig. 1. Concentration of the simulated CFC distribution (millimoles/m^3) from year 55 of a POP global 1/10^0 model run. The image plane slopes from near the ocean surface in the north to the abyss in the southern part of the domain.

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